

Herpetofauna of the Hawaiian Islands¹

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THIS STUDY was undertaken to determine the changes that have occurred in the herpetofauna of the Hawaiian Islands since the work in the early forties by Oliver and Shaw (1953). The work is a result of a field survey of most of the islands conducted by the authors during the summer of 1962. Since the purpose of the survey was to observe gecko vocalization, more data are available on this group than on the others. The islands afford a unique opportunity to observe a dynamic fauna since there are constant introductions from foreign sources. Periodical surveys have been made which furnish an investigator a well annotated history. Changes have been observed during each of the major surveys, made by Stejneger (1899), Snyder (1917), and Oliver and Shaw (1953).

In an accurate analysis of the faunal characteristics of the islands during 1943 when their study was conducted, Oliver and Shaw (1953), listed 8 species of amphibians and 15 species of reptiles. Since that time the house gecko, *Hemidactylus frenatus*, has been introduced. Two iguanid lizards, the Cuban anole, *Anolis porcatius*, and the horned lizard, *Phrynosoma cornutum*, have become established and are now considered to be permanent residents of the islands. *Anolis* was established by 1951 (Shaw and Breese, 1951) and *Phrynosoma* since that time. Hawaii's laws prohibit introduction of any snakes, but occasional specimens have been collected. Gopher snakes, *Pituophis catenifer*, and garter snakes, *Thamnophis elegans*, have been collected on Oahu, but are not considered to be established. These probably represent pets that have escaped and at the present time do not constitute a significant part of the fauna.

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REPTILIA SERPENTES (SNAKES)

Blind Snake (*Typhlops braminus*)

About 1930 this species was accidentally introduced on the island of Oahu with a shipment of palm trees from the Philippines which were planted around the new Kamehameha Schools in Kapalama, Honolulu. It became established quickly in the vicinity of the schools, and during the following decade spread into the residential areas of Honolulu. By 1947, it had been collected in an area several miles from the original locality (Fisher, 1948), and it now appears to occupy the lowland area over the entire island. It is unknown on the higher mountains, but this may be due to inadequate collecting efforts. The large amounts of top soil that are transported from one part of the island to another probably are responsible for the spread of this fossorial animal. Recently, *Typhlops braminus* has been collected in Kahului, the major port city of the island of Maui. While there are some restrictions on the transportation of soil around vegetation or domestic plants between the islands, certain people manage to evade them. Such shifting of top soil, potted plants, etc., as well as large-scale freight shipping by sea, probably is responsible for the introduction of the blind snake on Maui. Its establishment on the other islands is to be expected.

SAURIA (LIZARDS) GEKKONIDAE

Mourning Gecko (*Lepidodactylus lugubris*)

The first Hawaiians probably introduced this species during early population invasions approximately 1,000 years ago. The eggs are highly adhesive and can be seen clinging to mats and other household articles such as early immigrants probably brought with them. They have been recorded in the Panama Canal Zone

by Smith and Grant (1961), undoubtedly introduced by this method of egg transport. Today the species is found throughout the islands, from remote forests to the downtown areas of the largest cities. It is the most frequently observed lizard and is well represented in collections because of its gregarious habits, little fear of humans, and population concentration in areas inhabited by people. This common gecko apparently has adapted itself with great success to living in close association with humans. It is a common observation that these geckos occur in greater numbers in well populated areas than in more remote sections. Of a series of 21 individuals collected in a transect from an uninhabited area into a city, 10 were collected in a populous section, 5 from the fringe area, and 6 from the uninhabited area. In making this transect an attempt was made to maintain a constant unit of effort in each of the three habitats during the collections. The great number of numerous species of nocturnal insects attracted by the electric lights of the city probably is responsible, in large part, for the large gecko population in the city. This does not explain, however, the abundance of geckos in or near man-made structures that were remote from any lighted areas. In nonurban areas, they are definitely associated with open forests rather than with densely forested areas.

Observations of several individuals indicate that *L. lugubris* is rather sedentary and that the home range usually does not exceed an area of 6 or 8 ft in diameter. However, these lizards periodically migrate from one area to another. These movements are not a coordinated group effort, but appear to be a simultaneous evacuation of the normal home ranges of many individuals. During these periods, individual geckos have been seen moving across walls, down tree trunks, over sidewalks, etc. Such periods of excessive activity have not been correlated with season, rainfall, temperature, or other factors.

L. lugubris is active from shortly before dark until sunrise. Although highly gregarious, they show some aggression toward each other. A chirping noise is utilized in social behavior and a squeaking occurs during painful or aggressive encounters. Tail-waving has been observed in social interactions. The females are slightly larger than the males. The mean snout-vent

length of 26 females was 41.69 mm, ranging from 33.0 to 46.7 mm. The mean snout-vent length of 7 males was 35.96 mm, ranging from 32.2 to 42.4 mm.

Tree Gecko (*Hemiphyllodactylus typus typus*)

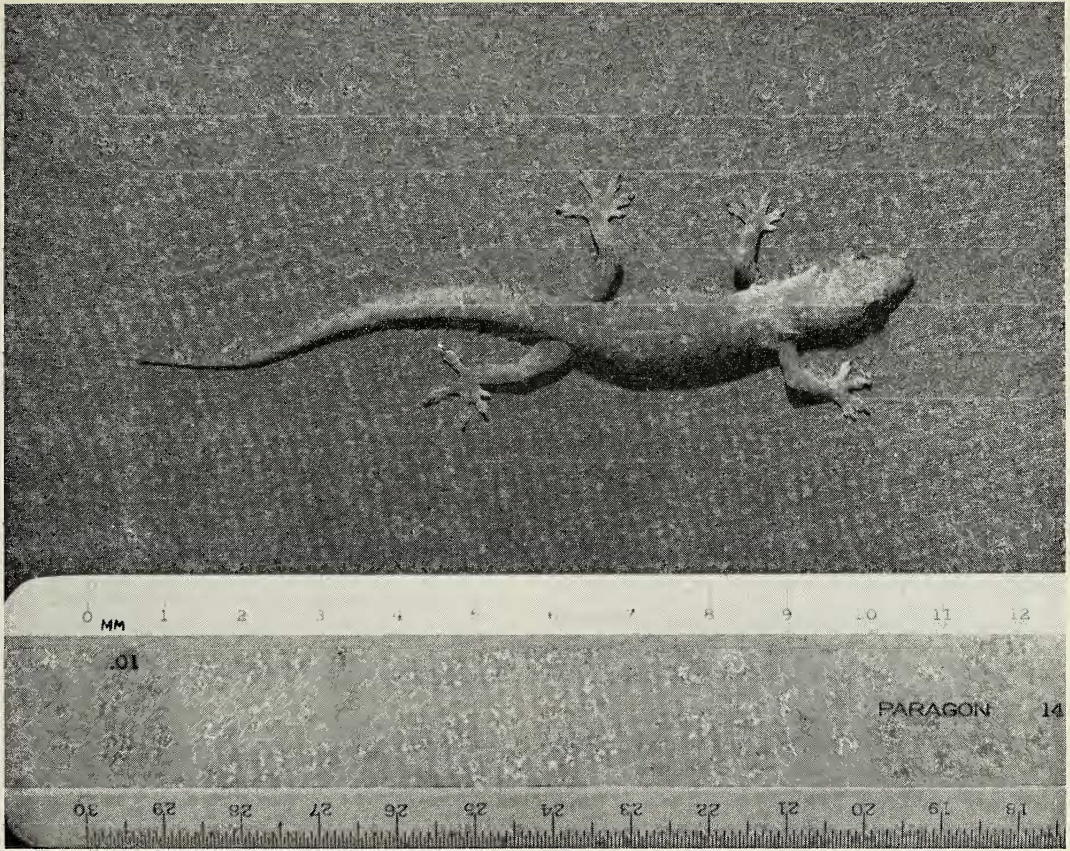
No significant changes have appeared in the density and distribution of this species since 1943; it remains rather rare. Of 161 geckos collected in Kailua on Oahu, only 5 were of this species; 4 of them were collected on the sides of buildings in the city and 1 from under the bark on a tree. They are extremely agile and wary lizards and it is much easier to collect them from the sides of buildings than from tree trunks. Hence we do not believe that our larger collection from the city buildings necessarily implies a larger population there.

H. typus typus is not a gregarious species; only 1 individual was collected from a well-lighted building which supported over 80 other geckos. On a darkened building about 30 ft away, 2 other individuals were collected about 10 ft apart. The only lizard found in close association with the tree gecko was the house gecko.

House Gecko (*Hemidactylus frenatus*)

This species is the latest addition to the herpetofauna of the Hawaiian Islands (Hunsaker, 1966). It was first observed in June 1951 in the city of Kailua, about 20 miles north of Honolulu. It is well established at the present time and appears to be rapidly replacing both *Hemidactylus garnoti* and *Lepidodactylus lugubris* in the cities on Oahu. *H. frenatus* can be identified easily by the series of enlarged scales which encircle the tail, exhibiting concentric circles of short spines (Fig. 1). These circles are separated by normal scales. This species has a cylindrical tail and lacks the lateral folds and loose femoral skin of *H. garnoti*. *H. frenatus* is very similar to the fox gecko in size and color, but it is much more aggressive. Not uncommonly it attempted to bite the collector.

Mixed colonies of *H. garnoti* and *H. frenatus* are rare. Apparently the new immigrant is much more successful a competitor than are the other species of geckos. This factor, and its greater aggressiveness, apparently are responsible for its rapid replacement of the fox gecko in urban

FIG. 1. *Hemidactylus frenatus*.

areas. *H. frenatus* has not been collected in areas removed from human habitation. In a transect which extended from an uninhabited area into the city of Kailua, 5 *H. garnoti* were collected in the uninhabited area and only 1 in the city proper. Conversely, 40 *H. frenatus* were collected in the city and none in the peripheral areas. Very few mourning geckos were found to be associated with *H. frenatus*. In Kuala Lumpur, Malaya, *H. frenatus* is quite common in the inhabited areas and *L. lugubris* is much more difficult to collect in the fringe areas. In the past, the well-lighted residential areas of Honolulu have been occupied by *L. lugubris* and the invasion of this habitat corresponds with findings of Church and Lim (1961), who stated that in Bandung, Java, *H. frenatus* preferred residential areas which were well-lighted and damp. In an area that has been under observation for the past few years, the disappearance of the fox gecko and the mourning gecko popula-

tion coincided with the appearance of this species. These large geckos appear to have a home range of an area about 12–15 ft in diameter. They are highly vocal and a distinctive series of five or six call notes can be heard up to 100 ft away. Aggressive or painful situations may provoke a prolonged squeak. This species occurred in close association with the stump-toed gecko (*Peropus mutilatus*). *H. frenatus* were observed in Kailua, in many parts of Honolulu, around the International Airport, and in the wharf area. Four individuals of this species were collected only in the harbor areas of Kahului on Maui, while *H. garnoti* and *L. lugubris* were collected in other sections of the city. This distribution indicates that *H. frenatus* has arrived only recently on Maui. None of these lizards has been collected on any other island. This is a large species; the largest individual collected was a male 58 mm in snout-vent length.

The current distribution of *H. frenatus* indi-

cates that it is quite successful in establishing itself in new areas. The species is very widespread in the Orient and in the Malay States. Grant (1957) recorded it from Acapulco, Mexico; Tanner on Saipan in 1948; in 1950 it was recorded from Morotai; Church and Lim (1961) recorded it in Java; Larry Richards collected it from Guam in 1947. In all probability representatives of the Mexico population were transported by early traders, and the recent range expansion is due to equipment and material shipped during World War II.

Fox Gecko (*Hemidactylus garnoti*)

The future of this species in the islands will be interesting to follow. At the present time it is uncertain whether *H. frenatus* is replacing this species in unpopulated areas. If the fox gecko is better adapted to living in forested areas, it will probably continue its existence in this habitat. If the house gecko is as efficient in displacing the fox gecko in remote areas as it is in the cities, the future of this long-term resident is questionable. The fox geckos have been established for many years and probably are one of the earliest inhabitants of the islands. In Malaya, there are areas where both *H. garnoti* and *H. frenatus* live in close association, and so it is possible that the two species will continue to be sympatric in Hawaii's fauna.

Of 12 eggs from the island of Hawaii which were laid during the last week of June, the largest was 17.0×8.9 mm, the smallest 9.4×8.7 mm. These measurements compare well with those of eggs of the same species recorded by Cagle (1946) for eggs from a population on Tinian (which had a mean of 12×7 mm). Measurements made 2 weeks later did not indicate a significant change in size. Of the 12 eggs 7 hatched, and the mean snout-vent length of the newborn lizards was 24.08 mm, the mean total length, 48.0 mm. The range of snout-vent length was 26.0–22.5 mm; the range of total length was 51.0–45.5 mm. These measurements are well within the range quoted by Snyder (1917) for Hawaiian populations: 39.5–56.0 mm total length.

The maximum incubation period for eggs laid in Hawaii and hatched at room temperature (74°F) was 64 days. Cagle (1946)

hatched a series of eggs of this species in a 45-day incubation period.

Stump-Toed Gecko (*Peropus mutilatus*)

There appears to be no significant change in the distribution of this gecko. It occurs in rather dense populations in some areas and is scarce in others. It is found away from the city of Honolulu in the back country and is quite common at the International Airport on Oahu. Females are slightly larger than the males. In a series of 17 females measured, the mean snout-vent length was 45.60 mm, with a range of 39.5–55.5 mm; for 34 males, the mean snout-vent length was 43.65 mm, with a range of 29.0–57.5 mm.

IGUANIDAE

Gray Cuban Anole (*Anolis porcatus*)

This species is well established on Oahu at the present time. Both large adults and immature forms are commonly seen in Honolulu. The original site of collection was in the Kaimuki section of Honolulu. It has spread to other nearby sections of the city and to Manoa Valley, and is presently established on the north side of the island, at Kailua. The first introductions were probably imported pet lizards which escaped. We can consider this species to be a permanent member of the fauna of Oahu. It has not been collected from the other islands.

Texas Horned Lizard (*Phrynosoma cornutum*)

An increasing number of reports and of specimens collected indicate that this species is probably established as a permanent resident of the Hawaiian fauna on the island of Oahu. These animals undoubtedly originated from escaped pets. They have been found from the slopes of Diamond Head throughout Honolulu to the xeric areas above Pearl Harbor. No concrete evidence has been obtained to indicate that a reproducing colony has been established, with eggs and hatchling lizards. Probably this lizard is reproducing, since immature specimens have been obtained from the islands, and the 10 or 15 reported is an unusually high

number to be accounted for by the escape of pet lizards.

SCINCIDAE

Snake-Eyed Skink (*Ablepharus boutoni poecilopleurus*)

No important changes have occurred in the population of this species. It is still rather common in some of the more arid sections, but it occurs in definitely localized populations. In some areas it is absent, although the environment is similar to that of other areas where the skink is common.

Moth Skink (*Lygosoma noctua noctua*)

At the present time, the moth skink is found only in a small area on the northern coast of Oahu, near Kahuku Point. There seems to be little doubt that the rapid expansion of *Lygosoma metallicum* is responsible for the decrease in the once large populations of the moth skink. The area in which it now occurs is similar to large areas of Oahu which are now occupied by the metallic skink and at one time were occupied by *L. noctua*. The increase in amount of land under cultivation has not been great enough to account for the reduction that has been observed. No data are available for populations once observed on Hawaii, Kauai, and Maui.

Metallic Skink (*Lygosoma metallicum*)

Few animals have been so successfully introduced as was the metallic skink on the island of Oahu. Its rapid multiplication on this island has produced remarkable numbers in the lower areas. It is aggressive with individuals of the moth skink, and it is certainly unafraid of humans. The success of the species probably is due in part to its apparent lack of fear of humans. It is easy to approach these lizards, and they can be found close to human habitations. The species is still known only from Oahu.

AMPHIBIA

Gold and Black Poison Frog (*Dendrobates auratus*)

This frog has been limited in its distribution only to the sites where it was released.

It was originally introduced in upper Manoa Valley in 1932. This site now has a well-established population of frogs which extends to lower parts of the valley during the rainy season. Additional plantings with subsequent establishment have been made in Waiahole Valley, and the population has been observed to fluctuate in size at this locality, again according to the amount of water available.

Bull Frog (*Rana catesbeiana*)

This frog is extremely prolific and is well established on all major islands. No major changes in the populations have appeared since the 1940s.

Green Frog (*Rana clamitans*)

Since its introduction on Oahu in 1935, no great expansion of the population has been evident. It is not common anywhere on Oahu and has not been reported on other islands.

Wrinkled Frog (*Rana rugosa*)

This species is well established and is quite common in some areas. The population size varies with the amount of rainfall available. During 1962 the populations of most amphibians were reduced to half the numbers found in 1961, when surface water was much more plentiful.

Marine Toad (*Bufo marinus*)

This species is found on all the major islands and is the commonest species of amphibian.

SUMMARY

A survey of the herpetofauna of the Hawaiian Islands was conducted during 1962 to determine any changes that might have occurred in the previous 20 years. New faunal species which have become established are *Anolis porcatius*, introduced in the late 1940s; *Phrynosoma coronatum*, introduced about 1955; and *Hemidactylus frenatus*, first observed in July 1961.

Other species have extended or contracted their ranges, but no other significant changes were observed. It was noted that populational variations in amphibians could be attributed to annual changes in available surface moisture.

The house gecko, *Hemidactylus frenatus*, is rapidly increasing in numbers and is apparently being introduced into the other islands from Oahu. The most important means of introduction appears to be by the movement of boat cargoes from one harbor to another.

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